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which were Flutes with four or five stops, like the Pipes of Shepherds; with these they played not in consort, but singly, and tuned them to Sonnets, which they composed in meetre, the subject of which was love, and the Passions which arise from the Favours or Displeasures of a Mistress. These Musicians were *Indians* trained up in that art for divertisement of the *Incas*, and the *Curacas*, who were his Nobles, which, as rustical and barbarous as it was, it was not common, but acquired with great Industry and Study.

“Every Song was set to its proper Tune; for two Songs of different subjects could not correspond with the same Aire, by reason that the Musick which the Gallant made on his Flute, was designed to express the satisfaction or discontent of his Mind, which were not so intelligible perhaps by the words as by the melancholy or chearfulness of the Tune which he plaid.”

The Bureau of Ethnology at Washington is now making preparations for the collection of data relating to the music and musical instruments of the various peoples of the new world, and many facts of an interesting nature will doubtless shortly be given to the scientific world in the hitherto comparatively untrodden field of native American music.

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ON THE OCCURRENCE OF FOSSILIFEROUS STRATA IN THE LOWER PONENT (CATSKILL) GROUP OF MIDDLE PENNSYLVANIA.¹

BY E. W. CLAYPOLE.

THE Catskill group of New York has been hitherto a great palæontological desert in American geology. Though much time and labor have been spent upon it by different geologists, little, I may almost say nothing, has thus far rewarded their labor. Here and there a few traces of life have been discovered, but these traces, faint and few as they were, have in many instances ended in disappointment, and now forty years after the establishment of the group by Professor Hall, the Catskill remains, even more than it was then, a great desert. The abundant life-remains that continue in New York to the very top of the Chemung there cease altogether. The abounding wealth of the Lower Carboniferous, especially in the West, sets in as soon

¹ Abstract of a paper read before the American Association for the Advancement of Science at Montreal, in August, 1882.

as the Catskill group is passed. But the Catskill group itself is a lifeless waste forming a complete break in New York and Pennsylvania between the Devonian and Carboniferous systems. Not a species, I believe, is known on both sides of it. The life of the Chemung in Pennsylvania died out and the life of the Lower Carboniferous came in, but the two faunas are distinct.

All the Devonian groups are connected by numerous species passing up from the lower to the higher, and often forming a high percentage of their total contents. But at the top of the Chemung this passing upward ceases. Even the two or three species of Testacea, formerly supposed to belong to the group, have been removed from it by the reference of the beds in which they lie to the Chemung or Portage.

It is worthy of notice that the equivalent beds in Great Britain have shown an almost equal poverty of organic remains. The Old Red Sandstone, or more properly speaking the Upper Old Red Sandstone (for it is incorrect to speak of the American Catskill as an equivalent of the whole of the Old Red Sandstone of England and Scotland), was for many years regarded as a desert, and so remained until by the labors of Hugh Miller, Charles Peach, Thomas Dick, Louis Agassiz and others; it was peopled with a fauna of its own—a fish fauna—of immense size and unique character. Sir Charles Lyell in his *Elements* says (p. 520): “For many years this formation was regarded as very barren of organic remains, and such is undoubtedly its character over very wide areas where calcareous matter is wanting, and where its color is determined by red oxide of iron.” Even now the fauna of the Upper Old Red Sandstone is but scanty except in fish and plants; the few Testacea from the beds at Kiltorcan in Ireland, forming but a slight exception to the general rule.

In regard to the poverty of the American Catskill, Professor Hall remarks in the *Geology of N. York* (4th district, p. 283):

“Thus far we know little of the fossils of the Old Red.”

And Mr. Vanuxem, speaking on the same subject says (*Geol. of 3d district*, p. 188):

“The fossils which have been observed in this group, in this State, so far, are but few in number, the group being very barren, and also in Pennsylvania where the rock has considerable surface exposure and great thickness”

Again: “Though shells and bones are rare in this group, plants appear to be much more numerous, accumulations existing

similar to those of the Ithaca and Chemung groups but in greater number and frequency, and giving rise to thin seams of coal, none of which, however, exceed a foot in length and breadth and an inch in thickness."

Professor H. D. Rogers (Geol. of Penna., Vol. I, p. 108) says of these same beds:

"This is a mass of very thick alternating red shales and gray and red argillaceous sandstones. It has very few organic remains. Among these is the *Holoptychius* and one or two other remarkable fossil fishes of genera distinctive of the Old Red Sandstone."

Professor Dana (Manual, 1874, p. 278) says:

"The rocks (Catskill) afford but few relics of life."

"Among animals, no corals, crinoids, brachiopods or trilobites are yet known. The coarse character of the beds accounts for their absence. There are some lamellibranchs and a *Euomphalus*,¹ these with fragments of fishes make up about all that is yet known respecting the fossil contents of the beds."

Mr. S. A. Miller, in his catalogue of the American Palæozoic Fossils, gives the following members from the Catskill or its equivalent groups:

Plants	7 species.	Gastropods	0 species.
Protista	0 "	Cephalopods	0 "
Polyps	0 "	Lamellibranchs	2 "
Echinoderms	0 "	Annelids	0 "
Polyzoa	0 "	Crustaceans	0 "
Brachiopods	0 ² "	Fishes	2 "

Assuming for the present the above list to be correct, it gives a total of eleven species in the animal and vegetable kingdoms recognized up to that date (1877) in the Catskill group.

A careful review of the above list of species with the necessary corrections to date will make a few changes both of addition and subtraction.

In the first place if we consider the plants, we find the following list of species attributed by different writers to the Catskill group:

- Cyclopteris jacksoni* Dn., Me., N. Y.
- " *hallana* Dn., N. Y.
- " *minor* Lsqx., Penna.
- " *obtusa* Lsqx., Penna.
- " *rogersi* Dn., Me.
- Sphenopteris laxa* Hall, N. Y.
- Rachiopteris pinnata* Dn., N. Y.
- " *punctata* Dn., N. Y.
- Iepidodendron gaspianum* Dn., N. Y., Me.
- Sigillaria simplicitas* Van., N. Y.

¹ This statement appears to be erroneous so far as *Euomphalus* is concerned.

² *Atrypa inflata* Con., given as a Catskill species, is so entered by mistake. It belongs to the Catskill shaly limestone.

This is scarcely the place for a technical dissertation on the identity or distinctness of the species here represented by the names given above. But it may be briefly remarked that to *C. jacksoni* is attributed the specimen figured in the Geological Report of the fourth district of N. York. It is also reported by Dr. Dawson from Perry, Me. Of *C. hallana* the very existence is yet in doubt. Mr. Lesquereux considers it a synonym of the preceding, while Dr. Dawson makes it distinct. *Cyclopteris minor* and *C. obtusa* are the best known forms from the Pennsylvania Red Sandstone. *C. rogersi* rests, so far as Pennsylvania is concerned, on a doubtful fragment in the collection of Professor Hall, and *Sphenopteris laxa* Hall, is a synonym for *C. hallana* Goep., or *C. jacksoni* Dn. (if these are distinct). In this way we find there are only three species of the six named above, concerning which little doubt of their identity remains :

Cyclopteris jacksoni Dn. = *Sphen. laxa* Hall = ? *C. hallana* Goep.

“ *minor* Lsqx.

“ *obtusa* Lsqx.

Add for the present to these, *Rachiopteris pinnata* Dn., and *Rachiopteris punctata* Dn., figured in the Geology of New York (3d dist., p. 191), and we have a total so far of five species reported from the Catskill group of Northeast America.

The Catskill *Lepidodendron*, of which a figure is given in the Geology of the Third District of N. York (p. 191), belongs, as nearly as can be determined from the engraving, to *L. gaspianum* Dn.

To these six species if we add the *Sigillaria simplicitas* of Vanuxem (Geol. of 3d Dist. of N. Y., p. —), admitting it, to avoid discussion, to be a plant, we have a total of seven species in all of vegetable remains from that part of the Devonian which has been considered to belong to the Catskill group.

Besides the plants there are a few relics of Testacea reported from this group, which we must notice. Two species only with numerous specimens have been assigned to it :

Modiomorpha augustata Vanuxem.

(*Cypricardites augustatus*.)

Modiomorpha catskillensis Vanuxem.

(*Cypricardites catskillensis*.)

Both are figured, but without description, in the Geology of the Third District of N. York (p. 186). But as the beds in which they were found have since been referred to the Chemung or even

to a lower group, there is no need to consider them farther. They must be cancelled from the Catskill fauna.

The only other fossils derived from any part of the Catskill group are fish remains, and these are the most important of all. From N. York and Northern Pennsylvania have been reported two or perhaps three species identified chiefly by scales. They are :

Holoptychius americanus Leidy.

Bothriolepis taylori Hall.

Sauripteris taylori Hall.

The first of these species rests solely on scales, and perhaps teeth ; the second on similar evidence, the third upon a fossil fin. It is, however, more than probable that the second and third belong to the same species. In that case there are two well-marked forms of fish which compose the whole Catskill fauna of this country. These fossils have a special importance from the fact that both in Europe and America they are the characteristic fossils of the Upper Devonian. The various " fish beds " form the basal plane of the Catskill group of rocks. According to present knowledge all above the lowest bed containing *Holoptychius* is Catskill, all below it is not Catskill. Here is a clear sharp line, at present, marking off the uppermost beds of the Devonian from all beneath them—a floor, as it were, for the group.

Five plants then are all the vegetable remains that have been thus far reported on tolerably good evidence from the Catskill group, and even of this small number it is quite probable that critical study will eliminate some. Two species of fish in like manner constitute the whole animal kingdom of the Catskill rocks.

It is right to add here that Professor J. F. Whiteaves, of the Canadian Geological Survey has recently described some fish from the Upper Devonian of Scaumenac bay, which may prove to be of equivalent age to the Catskill of New York and Pennsylvania. " These fish-bearing beds," he says, " are immediately overlain by the sandstones and conglomerates of the Bonaventure formation of the Lower Carboniferous."¹

The following species have been mentioned by Mr. Whiteaves from these beds :

Pterichthys canadensis

Phaneropleuron curtum

Eusthenopteron foordi.

Glyptolepis microlepidotus

Cheirolepis canadensis

¹*Canadian Naturalist*, Vol. x, No. 2 ; also *AMERICAN NATURALIST* for Feb., 1883.

From the same beds Dr. J. W. Dawson has mentioned (Q. J. G. S., May, 1881, p. 301) three species of ferns, viz :

Archæopteris magnacensis

“ *obtusa*

Cyclopteris brownii.

Should these beds prove to be of Catskill age, the five species of fish and two of the three ferns above named must be added to the organic remains of the group.

Lastly I must mention that quite recently the well-known Irish fern *Cyclopteris* or *Archæopteris hibernica* has been found and identified beyond doubt by Mr. Lesquereux from Susquehanna county, Pennsylvania.

In the district now under consideration the upper part of the Chemung group consists of greenish and yellowish shales, for the most part unfossiliferous or very scantily fossiliferous. Beds of red shale are occasionally met with but they are not thick. The passage to the Catskill group is somewhat abrupt. Red shale and brown sandstone suddenly form the mass of the rock, and afford a clear lithological base for these uppermost Devonian beds. They are apparently unfossiliferous for about 200 feet.

Above this occur two remarkable beds of brown sandstone charged with fish-scales. The lower of these two is about three inches thick and consists almost entirely of a mass of fish remains, chiefly scales, embedded in shaly sandstone rather harder than the over and underlying beds. The scales themselves are distinct in the rock but very difficult to extract on account of the crumbling nature of the stone. Their well-known impressions may be seen and often obtained, and so far as yet determined consist of the wrinkled scale of *Holoptychius americanus*, and the pitted scales of *Bothriolepis taylori*.

The upper bed lies about ten feet above the lower, is rather thinner, but abounds to an equal degree with the same organic remains.

These two beds—fish beds—afford us, so far as they extend, an indisputable palæontological base for the Catskill group in Perry county. These two species, as shown above, constitute nearly all that is yet known of the Catskill fauna, indeed it is scarcely too much to say that they may be regarded as the sole characteristic species of the group in America.¹

¹ In Scotland *Holoptychius* passes up into the Lower Carboniferous, but the species in the two systems are different.

If, therefore, we assume these fish-beds as the life base, and the commencement of the red shale as the mineral base of the Catskill, the two are only about 200 feet from one another, and in the immense thickness of the group in Perry county—about 6000 feet—this difference is quite insignificant. We are then supplied with a clear horizon to which we can refer all that is found above these limits.

About 200 feet above the fish-beds occurs a thin bed filled with Spirifers of a species as yet undetermined but very much resembling the *Sp. mesastrialis* of Hall. The specimens are as is usual in the shale beds, much distorted, and consequently difficult of recognition. This bed is only a few inches in thickness, and the 200 feet intervening between it and the fish-beds is made up of red shale with a few layers of yellow sandy shale.

About 300 feet of red and yellow shales and brown sandstone follow, somewhere in which interval, though not yet detected along the line of section, is a bed of red sandstone containing remains of Brachiopods. This bed is indicated by abundant loose blocks lying about on the surface of the ground.

The most remarkable bed in the whole section comes next, lying about 500 feet above the fish-beds. It is a bed of light yellow sandstone not more than ten or twelve feet thick where exposed. Most of it is unfossiliferous, but it contains one or more irregular lenticular layers which were once crammed with shells and other organic remains. These have been entirely removed by solution, and there now remains a honeycombed mass of sandstone containing excellent casts of the relics formerly embedded there. The most abundant of these—and it occurs in millions—is a lamellibranch shell closely resembling, if not identical with, one described by Professor Hall in the Geol. of New York as *Cypricardia rhombea* (*Cypricardites rhombæus*). Another less abundant species in the same bed as closely resembles *Cypricardia contracta* (*Cypricardites contractus*) of the same author. With these occur in less abundance remains of other lamellibranchs, crinoids and gasteropods which have not yet been worked out.

The bed above described has been traced over a considerable extent of country, and forms wherever it occurs a very convenient secondary horizon to which other beds can be referred.

The ground is in part concealed for a short distance above this point but where visible shows the same succession of red shale

and brown sandstone beds as already described. At about 300 feet higher—measuring at right angles to the bedding—occur two other fish beds, small when compared with those already mentioned, but equally distinct. The largest of them is only about half an inch in thickness, and the lower and smaller is a mere flake. They both show, however, the scales of the same genera, *Holoptychius* and *Bothriolepis*. These beds are useful as showing that these characteristic forms of the Catskill continued to live, and thus the beds already described, with their fossils, are hedged in above and below by remains of whose geological date no doubt exists.

Continuing above these second fish-beds, which are about two feet apart, we meet with a succession of beds of red shale and brown sandstone with a few greenish shaly layers until nearly 150 feet above them come in two or three thin green shales and blue limestone bands full of brachiopods and lamellibranchs of small size and species not yet determined. Another fossiliferous bed follows about twenty feet higher up. About 120 feet above this is a thin, soft, green shale full of a small *Beyrichia* and other fossils, and the section ends a hundred feet higher with a massive green sandstone containing a bed of vegetable remains almost forming a thin seam of coal.

We have, therefore, here a mass of strata, some of which are fossiliferous, extending nearly 1200 feet above the lowest *Holoptychius* bed, and nearly 1400 feet above the base of the red shale. This mass equals about one-fourth of the total thickness of the Catskill group in the county. It is right to add here that throughout this paper the terms Catskill and Ponent are used synonymously. The latter is, however, in Pennsylvania, the more definite of the two. Professor Rogers included in it all the mass of red sandstones and shales between the green Vergent (*Chemung*) and the Vespertine (*Pocono*) sandstone. In that sense the terms are employed here, without prejudice of future and further conclusions.

Whatever opinions may be entertained regarding the facts here detailed, they evidently guide us to one of the following conclusions:

a. That the lower portion of the Ponent red sandstone and shale (Catskill) is less barren of organic remains than has been supposed; or,

b. That *Holoptychus* and *Bothriolepis* are not exclusively Catskill forms;¹ or,

c. That an immense mass of the Ponent group must be removed from its present position and relations.

The fossils they contain belong apparently in part to the Chemung group below and the Lower Carboniferous group above. Another part is seemingly peculiar.

This is not the place to enter upon any discussion of the significance of the facts here presented. The following summary may, however, be useful and not without interest.

The Catskill group—that is, the rocks lying between the base of the lowest bed containing *Holoptychus* and the Lower Carboniferous or Vespertine conglomerate—have hitherto been known to contain only the following fossils:

Plants	5	Gastropods.....	0
Protista	0	Cephalopods	0
Polyps.....	0	Lamellibranchs.....	0
Echinoderm	0	Annelids	0
Polyzoa	0	Crustaceans	0
Brachiopods	0	Fishes	2 or 3

The beds here described of indisputable Catskill age supply the following results:

Plants		Gastropods.....	present. ⁴
Protista.....	0	Cephalopods	?
Polyps.....	present ¹	Lamellibranchs	present ⁵
Echinoderms	present ²	Annelids	?
Polyzoa	0	Crustaceans	present ⁶
Brachiopods	present ³	Fishes.....	present

Thus only the subkingdom Protista, the class of Polyzoa and perhaps the classes of Cephalopods and Annelids remain unrepresented in the Catskill group.

1. Polyps are represented by the genus *Zaphrentis*.
2. Echinoderms “ “ Crinoidal remains.
3. Brachiopods “ “ the genera *Spirifera*, *Lingula* and *Rhynchonella*.
4. Gasteropods “ “ the genus *Pleurotomaria*, &c.
5. Lamellibranchs “ “ Cypricardites, &c.
6. Crustaceans “ “ “ *Beyrichia*.

¹ See Proc. Am. Phil. Soc., 1883, “On the occurrence of *Holoptychus* below the base of the Catskill.” E. W. Clappole.